A reprint from July, 1970
Vol. 19, No. 7

computers
and automation

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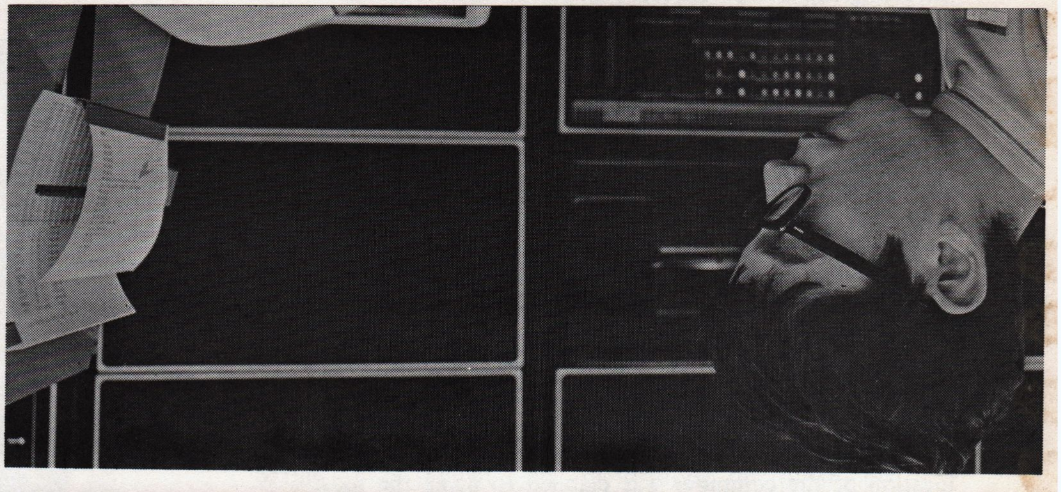
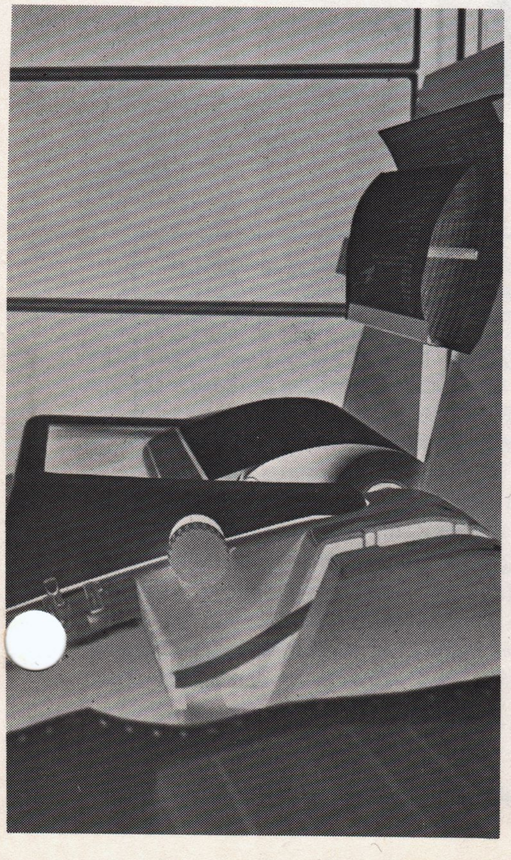
Thinking . . . . Computer — Aided





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"In the coming decade, schools will stop groping their way along the path of computer application, and will develop many more uses – more sophisticated uses – of the computer's power."

If the world of computers is a fast-moving one, the world of computers in the hands of innovative high school instructors and students is dazzling. Recently, a number of developments have altered not only the way secondary schools use computers, but also the way they buy them.

One area of significant recent growth has been the increasing number of schools that are banding together to help one another finance computers and explore ways to use them.

Time Sharing

For example, four communities in Rhode Island have established a project to offer low-cost computer training in their high schools. The Northeast Rhode Island Computer Project (NERICOMP) will give every high school student in the towns of Cumberland, Lincoln, North Smithfield, and Woonsocket exposure to a computer.

The project purchased a small time-sharing system that enables up to seven users to have access to the computer simultaneously. The cost of the system was carefully analyzed – by sharing the purchase price of the computer, the per terminal cost was less than $5,000. The ultimate location of the computer was planned to make the most economical use of the telephone lines required to connect the terminals and the computer. Now, each school has a computer terminal of its own, and the educational consultant who established the project feels that every school in Rhode Island should have access to a system like this within two years.

A regional educational service agency in Iowa, the Schools Information Center, offers time-sharing services to nine schools in Muscatine, Scott, and Clinton Counties and to a high school across the Mississippi River in Moline, Illinois. The center, located in Bettendorf, Iowa, gives each school immediate access to the computer just by dialing a telephone number. Portable teletypewriters permit the computer terminals to be moved to the classroom or laboratory where they are needed.

The Advantages of Pooling Resources

The reasons for pooling resources are best explained by Robert Haven, director of Project LOCAL, an organization

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made up of five Boston area high schools, and one of the first groups formed to explore the cooperative use of computers.

"There are some functions that it was felt could be done centrally and distributed to five places as easily as one," according to Haven. "For instance, overall planning and direction could be done centrally, eliminating duplication. A central organization could create and distribute teacher resources and text materials, and provide in-service training of the instructional staff. Project LOCAL's administration also provides for the maintenance of computers and teletypewriters, and carries out the project's time-sharing programs, as well as selling time on its machines," Haven said. "We also have written software – mainly small drill-and-practice routines – and we have conducted evaluations of computers in improving mathematics and science programs. Finally, there is only one approval needed when applying for federal and state funds.

"Mainly, these are things the individual schools felt they could not do more effectively by themselves, or things they would need extra money to do."

Simulation in Science

Science instructors, particularly, have begun to assign a larger role to computer simulation in the classroom and laboratory. Most commonly, the computers are used in two ways:

a. The computer is programmed to simulate a certain problem, such as a chemical reaction, a physical phenomenon, or a social or historical situation, and the student enters his own parameters into the program. The computer calculates the results.

b. The computer is programmed to simulate a certain experiment. The student conducts his own experiment, takes data from it, and compares his measured data against the computer's simulated experimental results.

"The computer gives the students an operating example of what Mendel's Law is and how it operates."

An example of the first category of classroom simulations is a program used by the Huntington Project in New York that demonstrates Mendel's Law of heredity in plants. Mendel crossbred plants with different characteristics such as height and color, and calculated the mathematical probabilities for each of the resulting generations of hybrid plants. In the computer program, a student enters the variables – height, color, and other characteristics being considered. The computer analyzes the input and types out the characteristics of each succeeding generation, based on Mendel's probabilities. Such an experiment obviously would be impractical to perform in a laboratory simply because of the time involved; a large number of generations could take years to develop. Yet, the computer gives the students an operating example of what Mendel's Law is and how it operates.

Apollo Moon Landing

Another example is an interactive program written by high school students in Lexington, Mass. It simulates an Apollo moon landing – the entire burden of landing the spacecraft is on the person using the program. The simulation starts with the spacecraft at zero seconds, 120 miles above the lunar surface, at a velocity of 3,600 miles per hour. A "radar" check is made every 10 seconds, along with a check of the velocity and remaining fuel. At each radar check, the user must tell the computer the amount of fuel he wants to fire during each of the remaining 10 seconds. The object is to land safely – a safe landing requires a speed of less than a tenth-of-a-mile per hour, with no fuel left.

"This simulation [of a lunar landing] allows a physics student, who has studied the effects of gravity and Newton's Laws of motion, to put the theories he has learned to work."

This simulation allows a physics student, who has studied the effects of gravity and Newton's Laws of motion, to put the theories he has learned to work. The likelihood of a perfect landing on the first attempt is rare; a student will probably have to make calculations, which will reinforce the concepts he learned, to determine the decisions he will make. And the student who wrote the computer program had to do extensive research into lunar landing principles and physical laws, which helped him learn to apply the scientific principles he was taught.

Civil War Battles

Another program in this category simulates 14 Civil War battles. Two students, one representing the North, the other the South, manipulate men, money, and strategy, which in turn affect the morale, casualties, and desertion rates of each army, as they try to "win" each battle. The program, although technically a game, is also an outline of the major battles of the Civil War, with much of the information based on actual facts and figures. The history student learns about the battles by actually simulating the fighting of them.

Simulating Experiments

An example of the second class of simulations, where the computer simulates the experiment and the student compares his data against the computer's, is a chemistry experiment where students combine magnesium and hydrochloric acid to produce hydrogen gas. Students type laboratory data from their experiments into the computer (several experiments are done independently during the same laboratory period). The computer calculates the average readings of the experiments, which enable the class to calculate results and make a laboratory report.

Each group doing an experiment must make two sets of calculations: a set based on the data the group obtained from the experiment, and a set based on the average readings of the entire class, which are provided by the computer.

Another part of the program, however, known only to the teacher, makes the calculations necessary for the laboratory reports. The computer makes the calculations; and the instructor uses the printout to correct student papers or as a basis for post-lab discussion. It can be given to a student who was absent from the laboratory or to a student who was having trouble with the calculations and needed extra help.

Apart from the area of simulation, an interesting development from the computer industry's point of view is the increasing number of formal computer science courses being offered to high school students for academic credit. The best of these courses teach the student assembly language programming, and they may have a noticeable effect on the industry. Courses such as those offered at Amity Regional High School in Woodbridge, Conn., and Deerfield High School, Deerfield, Ill., for the first time make an important point – that vocational training in computer science can be given at the secondary school level.

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Career Training

The computer science course at Deerfield High School, for instance, gives students going on to college a knowledge of computers and the ability to use them in college work. But it also prepares students not going to college for jobs as programmers and maintenance technicians. The first eight weeks of the 15-week program give the student a "nuts-and-bolts" background in computers and logic design. The course covers such basics as binary and octal numbering systems, Boolean algebra, truth tables, problem solving, and an introduction to electronic components. The actual computer science begins in the ninth week with a study of input and output media. In the tenth week, the students get into flowcharting and programming.

Combined with work done on the computer in other classes, the computer science courses give high school students an in-depth knowledge of assembly language, enabling them to get into a program to modify it or give it extended capabilities. This could lead to challenging, well-paid positions in the computer industry for high school graduates who have neither the resources nor the desire to attend college. The computer industry relies on colleges teaching computer science for its supply of programmers, but there are not nearly enough graduates to meet the demand. Many college graduates with backgrounds in subject matter principles – mathematics or science – can write programs in a high-level language such as FORTRAN or BASIC; but they have no experience with lower level languages.

"The area of technical and trade schools is one that offers room for innovation and creativity for computer use."

The Software Technician

This will possibly create an area for a new breed of person – the software technician – who does not have a background in higher mathematics or science and could not, for instance, write a Fourier transformation program. But he could write something like an input/output routine with interrupts for multiple terminals that would be incorporated into the Fourier transformation program.

The computer science courses and computer clubs in secondary schools have turned out their share of proficient students: at the Taft School in Watertown, Conn., two students adapted SNOBOL-3 (String Oriented Symbolic Language), which was designed to run on larger machines, to a small computer with only 4,096 words of memory.

Recently, one student in Massachusetts was solicited by a computer company to take a job with them; unfortunately, he had to turn it down – he was only 14 years old.

Technical and Trade Schools

Technical and trade schools have found new uses for computers during the past year. Don Bosco Technical School in Paterson, N.J., is using its small computer in its machine shop to generate numerical control information, such as plotting x and y coordinates. The school does not have numerical control equipment; so students cut an NC tape and read it to a machine operator, who makes a part using the information. The computer allows students to machine corrected parabolas and ellipses by giving the students the capability to calculate a coordinate to a non-integer power, such as $X^{3.14159}$. Using the computer gives the students experience with NC directions and formats when they begin working in industry.

The area of technical and trade schools is one that offers room for innovation and creativity for computer use. Today, students taking electronics courses in technical schools end up qualified to maintain hardware. If there is a software problem in a computer system, the user has to send for another person, the software specialist, who can work in assembly language.

Technical schools that offer students courses in assembly language programming along with electronic principles, could begin to phase out the hardware maintenance specialist and software specialist designations, replacing them with a computer maintenance specialist capable of troubleshooting and repairing all aspects of a computer system. This ability would give technical school students a more marketable skill in the job market.

The innovations started in the last year make it a landmark year in computer education. In the coming decade, schools will stop groping their way along the path of computer application, and will develop many more uses – more sophisticated uses – of the computer's power. Instructional methods using that power will bring more and more meaning and depth to secondary education. ☐

Printed in U.S.A. 088X 00171 1339 / B 12 20